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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/577,938	05/03/2006	Timothy J. Phillips	1241158	5737

23117 7590 05/11/2010
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EXAMINER	
WEISS, HOWARD	

ART UNIT	PAPER NUMBER
2814	

MAIL DATE	DELIVERY MODE
05/11/2010	PAPER

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RECORD OF ORAL HEARING

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex Parte TIMOTHY J. PHILLIPS and TIMOTHY ASHLEY

Appeal 2009-007560
Application 10/577,938
Technology Center 2800

Oral Hearing Held: April 13, 2010

Before MARC S. HOFF, CARLA M. KRIVAK, and THOMAS S. HAHN, *Administrative Patent Judges.*

APPEARANCES:

ON BEHALF OF THE APPELLANT:

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THE USHER: Calendar No. 8, Appeal No. 2009-007560, Mr. Spooner.

JUDGE HOFF: Good morning.

MR. SPOONER: Good morning. My name is Stanley Spooner. I'm representing the assignee of record which is Qinetic Ltd., a UK R&D Company. The invention that we're talking about, or purported invention, relates to semiconductors; in particular, narrow band gap semiconductors which are subjected to strain. All right, application of strain to semiconductors is an established way of altering the characteristics in the band gap. That's described in Applicants' specification page 1, lines 15 and 16. Tensile strain semiconductors are known and they're detailed in the specifications, such as the MOSFET disclosed in U.S. Patent 5,382,814. But there, the induced strain is in a wide gap, a wide band gap device, and it specifically states that it doesn't change the operation of that device. And that's at the specification page 1, lines 16 to 24. Our Applicants found that placing a transistor's narrow band gap region, not a wide band gap but a narrow band gap region, under compressive strain provides significant benefits, especially for a P-doped, or excess hole band gap region. And, that's at the Application page 2, lines 1 to 3.

All right, so, the critical features of the invention that we're talking about today is that it's a narrow band gap region, that it's under compressive strain, and that that region is comprised of doped P-type material or a material containing an excess of holes. All right, that's clearly set out in the first -- well, in the body of Claim 1 and the first 3 lines of Claim 16. The Examiner has a rejection. Anticipation is the basis under Section 102 of both of these Claims, by two Phillips references. And Mr. Phillips, the

Inventor in -- or at least co-inventor, in those references, is a co-inventor of this one. So, this is something that he has improved upon. So, the question is, do either of his previous references disclose every element and every interrelationship between elements that we Claim. And, our contention is that it doesn't. Now, the Examiner dropped the 112 rejection in the Examiner's Answer, and I would just note that the issues regarding that 112 rejection were raised in a pre-appeal brief -- supporting statement. The Examiner, and the panel who reviewed it, apparently ignored it because they passed the whole thing on. But, in any event, turning to the Appeal Brief and the Reply Brief, Sections B and C, it might be helpful to understand what we're talking about, in terms of band gap.

If we draw a diagram such that the horizontal is density -- the state density, and vertical is the electrical energy required to shift bands and, if the lower area is the valence band and, if the higher area is the conduction band -- I think I learned this in physics sometime but I've forgotten it since, so, it helps to go through it a little bit. The electrons are in clouds, in valence clouds, around a nucleus. For something to conduct, an electron has to get knocked off of that band, the valence band, so that it is free to conduct. And so, this is an energy difference between the electrons in their valence bands, and the electrons that have been knocked loose, so as to provide a conductor. All right, for metal materials, or other common conductors, there is no gap here. This conduction band is right here, so it doesn't take any increased amount of energy. You apply a potential and you get a current flow. For insulators, you have a very wide band gap, this gap between the two bands. That's an insulator. It takes an awful lot of energy to break down that insulator and get an electron to move from the valence to the conduction

band. Semiconductors have fairly narrow bands and, depending upon their construction and everything else, you can move electrons in certain circumstances, from the valence to the conduction band. So, it does provide conduction to some extent. It's either a variable insulator or a variable conductor, however you want to think of it. We're concerned with a fairly narrow subset, narrow band gap, semiconductors. Applicants identified, in their research, as evidenced by their previous patents and patent publications, that you can bias the quantum well, bias both a quantum well field effect transistor, and a bipolar transistor. So that, by the use of differing doped compounds, and that's doping is different from the doping of this narrow band gap region semiconductor material. So, typically, they may be made of indium antimony or indium antimony aluminum -- aluminide. The presence of that three- component layer in amongst a bunch of two-component layers, in other words indium antimony, antimonide, well -- the, the lattice structure of the surrounding layers is smaller than the lattice structure of the sandwich layer. And so, you grow these layers by epitaxial growth, or something like that, so that the crystalline structure lines up; and what happens is when you put this narrower construction, this smaller lattice, down, and then you put a layer of the indium antimide -- antimony on there, it constrains it. It squeezes it in to fit with the latticework of the underlying layer. And the same thing, if you put another layer on top of it, of the underlying material, it also squeezes it a little bit more so that the lattice connections line up. That, basically squeezes, or puts under compression, that intermediate layer.

So, that's what the Applicant's invention is doing. How you get compressive strain depends upon the construction -- alloy that you're using,

the ratios of the various alloys. It also depends on the relative thickness. We'll see how that's significant in one of them. If we look at the Phillips '674 patent, and that's -- by the way, that's discussed in our specification, on page 2, line 17, since it's one of our co-inventors' own publications. And, the Examiner has cited page 10 and figure 7 of Phillips '674 as being particularly pertinent. And, if we look at that, it shows layer 22, which is the narrow band gap region; and that's indium antimony, and then the regions around it, 21 and 23, below and above it are the indium aluminum antimony alloy. So, the presence of those alloys, above and below, will compressively squeeze that inner layer, which is the narrow band gap region. That the -- what they call the principal conduction channel. However, he specifically states, on page 10, that with regard to figure 7, that it's not doped, he says undoped indium antimonide, I guess is the way you pronounce it. So, that's at line 17, on page 10. And, he then says that that combination of elements and thicknesses, and concentrations in the alloy, provides "strained balanced" at the lattice constant -- of that alloy. In other words, he specifically says no compressive strain and no doping of that narrow band gap area. So, in our view it's impossible to have anticipation with that reference, with the '674 reference.

JUDGE HOFF: Counsel.

MR. SPOONER: Yes, sir?

JUDGE HOFF: Does your specification define compressive mechanical strain?

MR. SPOONER: It's a well known term of art. It's not been contested by the Examiner. And, as we discussed in the background, it is known to strain. Mostly, it's known to tensilely strain these things, and we

provide an example of that, so the issue of how much is compressive and how much is strain is sort of relative, but it's a well known term of art, I believe. It's not been raised thus far. So, if we turn to --

JUDGE HAHN: Counsel. Counsel.

MR. SPOONER: Yes, sir?

JUDGE HAHN: In that same vein, what does strain balanced mean?

MR. SPOONER: Strain balanced means that the -- it's a term of art. It means that the strain is the same. That there is no strain. That, that it's balanced. We had another case that was -- went up before the Board -- where they introduced purities, or impurities, in the latticework to get the strain in, in -- I think it was -- or solar panels, to get the latticework of different doped layers to be the same. So that you didn't strain them. Because, what happens is if you strain them, in other words one is compressive, one is bigger, it causes dislocations and reduces the conduction of the solar cell.

Here, we're using strained balance in exactly the same way. It means the latticework or the lattice constant of the narrow band gap area, or as he calls it, the conduction area, is the same as the above and below layers. So there is no compression or tension. It's the same. It's strain balanced.

JUDGE HAHN: Okay. Now the specification, as I understand it, says that if you have an indium antimonide layer sandwiched between two indium aluminum antimonide layers, there will be compressive strain.

MR. SPOONER: Yes. That's the explanation of how the invention works.

JUDGE HAHN: Okay. So, what we're looking at here, at Phillips '674,
we don't have that structure, do we? Because if we did we would have compressive mechanical strain, would we not?

MR. SPOONER: Yes, sir. Yes, sir. Absolutely. Firstly, we don't have -- we do have the sandwich of indium antimonide between the other two layers, but we have thicknesses and we have concentrations of the materials in the top and bottom layers that are strain balanced. In other words, you could change the characteristics, the percentages of the indium aluminum and antimony in that alloy, and you could come up with a strain inducing layer with respect to the indium antimonide. But, they teach it. They teach the opposite. They say you want strain balance, so that you don't have this problem with dislocations and other things of that nature. They also specifically say it's undoped indium antimonide. And our Claim, of course, specifically requires that it either be P-type or have an excess amount of holes. And that may be saying the same thing. I think it's two different ways to say the same thing.

So, yes, they show an arrangement of elements that, if they had doped the center section and if they had gotten the right concentrations and/or thicknesses to provide compressive strain, they'd have our invention. And, if Mr. Phillips had come up with it earlier, he'd have probably claimed it in this disclosure.

JUDGE HAHN: Now, in the preceding paragraph, the last sentence, he does mention an embodiment with strain and quantization effects included. What are your positions with respect to that last sentence?

MR. SPOONER: Well, he doesn't say that it's compressive strength,

firstly. So, we have fifty-fifty shot at it being wrong. And, there's no disclosure of any -- the -- indium antimonide being doped. So, I mean, he mentions the word strain.

JUDGE HAHN: Yes. Yes.

MR. SPOONER: There is no doubt. But, there's no teaching of our arrangement, which provides not only the compressive strength but the P-doped narrow band gap region.

JUDGE HAHN: Okay. Counsel, with respect to the doping of the indium antimonide, we noticed in the Reply Brief that that argument was made. Was that argument made prior to the Reply Brief? Was it in the Appeal Brief or raised during prosecution?

MR. SPOONER: Can you point me to where, in the Reply Brief?

JUDGE HAHN: I'd suggest page 6? Possibly the last sentence of the first full paragraph, "While the Examiner is correct in noting that the elements contained in the differing layers are the same elements it doesn't indicate the existence of any P-type material or excess hole material."

MR. SPOONER: Right. I think that's a correct statement. Whether it was made in an Appeal Brief or an Amendment, that's hard to say -- I can take a look. All I can see in the Appeal Brief we've referenced the language that says -- he said -- actually the reference says "it should be noted that, in all cases, the layers are nominally undoped but may contain unintentional doping of either type." So, he suggests that slightly less than perfectly purified alloys could be used. But, there is no teaching of the doping. As to whether the Examiner understood that argument or was responding to it, I'm just not sure. But, I think we put that in there because the Examiner stated, in his Answer -- I think it's subsection 2, he stated that

"if the composition is physically the same, it must have the same properties." And, he's right. If the composition was shown, it must have the same properties. But, the composition wasn't shown.

JUDGE HAHN: And your argument being because it wasn't shown to be doped?

MR. SPOONER: It wasn't shown to be doped and it wasn't shown in the concentrations that -- or the thicknesses -- that will result in compressive strain. So, it's those two features that are missing. You would have to get to a particular combination of percentages in the alloy, plus the thickness necessary, so that that would actually compressively strain this narrow band gap region. And, that's what they've missed. And what the Inventor subsequently discovered. And, again, in that case, the Examiner -- in each of these instances we've asked the Examiner to tell us where it is? Where it is? Show us where there is any disclosure of doping of this narrow band gap region.

JUDGE HAHN: Could you cite to that, please?

MR. SPOONER: Excuse me. Where?

JUDGE HAHN: Yes, where in the record?

MR. SPOONER: I'd have to go back through all of the Amendments.

JUDGE KRIVAK: Can I help? Is it page 9 in the Appeal Brief, right below where you just read?

MR. SPOONER: Yes, your Honor. That's where I was. There's no disclosure in Phillips ‘674 that there is any doping which would inherently provide "at least one narrow band gap region under compressive mechanical strain."

Again, should the Examiner persist in this unfounded allegation, he is

respectfully requested to indicate specifically where any such teaching exists in Phillips ‘674. And, then, that subsequent discussion -- it is possible that because Phillips ‘674 combination of elements is similar to the combination of elements set out in the present specification. The Examiner may believe that "compressive mechanical strain" is somehow inherently disclosed in Phillips. However, as discussed in the present specification, on pages 4 and 5, variations in the layer thicknesses as well as differing lattice content -- constants of the materials can be combined to provide types of mechanical strain, both compressive and tensile. But, it's not recognized that compressive mechanical strain would have any disclosed benefits. So, Phillips ‘674, you would have to decide, okay I'm going to P-dope or provide excess to the band gap region semiconductor material and I'm going to use sandwiching layers that give you a compressive strain. And he would have to do both of those to come up with our invention. Thank you for the cite; I was a page early.

All right. And again, the Examiner has had the opportunity to tell us, in the Examiner's Answer, and he just didn't. So, I'm assuming that he can't find -- that there is nothing in there. If we look at Phillips ‘337 -- if you add up -- and it talks about a P-plus doped layer in there. But he also talks about that layer as being 0.12 microns thick. And then he has a number of other layers which are all alloys, having the different thickness, and they are so significantly thicker that you wouldn't have the compression. In other words, he has a lower layer and then he has these layers stuck on the end of -- on the sides of it. And, as we pointed out in the Brief, the InAlSb layer is less than .0004 of a percent of the thickness on the left and less than .00012 percent of the total thickness on the right. So, the question is, will that layer

compressively strain the band gap region? I don't think so. There is no evidence introduced by the Examiner that that very thin layer will introduce any compressive strain to the much thicker InSb layer 12. The Examiner admits, in his Answer, page 6, the end of section C, that he has no evidence to support his opinion. He says, "while this not explicitly stated in the rejection it is implied in view of the previous analysis and statements." Now, I can't fight with implications but I think the burden is on the Examiner, to show us where this is. Where both of those things are. And, he just hasn't done it.

So, I don't think that there's a prima facie case of anticipation because all of the claimed elements and claimed interrelationships aren't shown. Clearly, if there's no anticipation and those elements are not shown in one or more of the references, they're certainly not going to be obvious in view of the references. And actually, both references actually teach away from the claimed invention. So even if he were to show somewhere where they existed, the ‘674 patent teaches undoped and strained balanced; so both of those teach away. And the ‘337 teaches doped but unstrained layers whether compressive or tensile. So, I just --

JUDGE HOFF: Counsel. Your time is about to expire, if you'd like to take about another minute to wrap up.

MR. SPOONER: I'm done. That's my wrap-up.

JUDGE HOFF. Very well.

MR. SPOONER: Any other questions?

JUDGE KRIVAK: None for me.

JUDGE HAHN: Counsel. The thickness argument, was that made in an Appeal Brief? Help these poor eyes.

MR. SPOONER: The thick -- I think that section that we just read, on page 9, last full paragraph, midway down, it says however, as discussed in the present specification

Whereupon, the proceedings, at 9: 31 a.m., were concluded.